



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Predicting the Hardness of Glass Surfaces

an invited talk

Smedskjær, Morten Mattrup; Mauro, J. C.; Yue, Yuanzheng

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Smedskjær, M. M., Mauro, J. C., & Yue, Y. (2011). *Predicting the Hardness of Glass Surfaces: an invited talk*. Abstract from Materials Science & Technology 2011 Conference & Exhibition, Columbus, United States.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Predicting the Hardness of Glass Surfaces

Morten M. Smedskjaer,^{a,b,*} John C. Mauro,^b and Yuanzheng Yue^a

^a *Section of Chemistry, Aalborg University, DK-9000 Aalborg, Denmark*

^b *Science and Technology Division, Corning Incorporated, Corning, NY 14831, USA*

* Corresponding author. Tel.: +45 99407240. E-mail address: m.smedskjaer@gmail.com

High-strength, high-hardness glasses are currently one of the most important research areas in the glass community. However, a theoretical prediction of glass hardness has hitherto been impossible. Here, we extend the temperature-dependent constraint theory to quantitatively predict hardness of glasses, taking the ternary soda-lime-borate glassy system as an example. The advantage of applying constraint theory is that the key physics governing glass hardness can be treated analytically without the need for molecular dynamics or other complicated numerical solutions. By comparison of modeling results with experimental data, we reveal that hardness is governed by the number of network constraints at room temperature and that a critical number of constraints is required for a material to display mechanical resistance. Furthermore, we have modified the surface compositions of the borate glasses and show that the resulting change in hardness can be predicted by considering the number of constraints in the modified surface layer.